1853MNRAS..13..256F

the secular variations is formally investigated, or in the fifth volume, containing historical notices of the labours of Newton and his successors on the theory of gravitation (with the exception of perhaps a very obscure allusion to the subject at page 319 of tome v.) It may be stated that the inadequacy of the analysis of Laplace, to establish the stability of the planetary orbits individually, without having recourse to numerical calculation, had been already pointed out by Le Verrier and others (*Comptes Rendus*, 1840, 1$^{\text{ier}}$ Semestre, p. 526).—R. G.]

Results of Micrometrical Measures of Double Stars made at Tarn Bank, Cumberland, from 1850·2 *to* 1853·4. By Isaac Fletcher, Esq., F.R.A.S.

The author commences his paper, by referring the reader to the tenth volume of the *Monthly Notices*, for a description of the instrumental means employed by him in obtaining the micrometrical measures here presented to the Society.

The telescope employed is a 6-foot achromatic refractor of 4·14 inches aperture, mounted equatoreally in the English fashion on a polar axis of mahogany, and driven by clock-work. The mounting, in fact, appears to be almost precisely similar to those of the instruments of Mr. Bishop, Lord Wrottesley, and the one which formerly belonged to Admiral Smyth, but which now adorns Dr. Lee's Observatory at Hartwell. The object-glass seems to be of first-rate excellence, as is abundantly shown by the measurement of such stars as ζ *Herculis*, δ *Cygni*, &c., and by the fact that, under favourable circumstances, it bears a power of 600. The measures have all been executed with a parallel wire micrometer, and a deep red illumination of the field of view. The hour-circle is *loose* on the polar axis,—an arrangement which appears to be convenient and advantageous, and Mr. Fletcher strongly recommends its general adoption. The entire instrument is the workmanship of Mr. Cooke of York. The catalogue of observations incorporates about 5200 *individual* measures, which are represented by about 280 *sets* of measures, most of the sets containing eight measures of position and *sixteen* measures of distance. In consequence of the greater liability to error in observing distances, Mr. Fletcher seems to have taken great pains to insure good results by a large accumulation of measures of this element.

Stars of an ascertained binary character seem chiefly to have occupied Mr. Fletcher's attention; and, accordingly, the catalogue contains numerous observations of γ *Virginis*, ξ *Ursæ*, 70 *Ophiuchi*, *Castor*, ζ *Herculis*, and other stars of interest. The catalogue is followed by a synopsis of *final* mean results.

Mr. Fletcher gives notes on some of the more remarkable objects to which his measures have reference, comparing his results with those obtained by other astronomers.

We here insert some of these notes:—

1853MNRAS..13..256F

36 *Andromedæ.* Σ 73.

This object has changed its position nearly 30° since it was first measured by Struve, and possibly the distance may have very slightly increased since that time, as it was occasionally *separated* by my refractor.

			°		″
Struve............	1832·14	Position	307·80	Distance	0·847
Dawes, B*	1841·81	—	320·75	—	1·076
Fletcher	1851·93	—	336·38	—	1·116

γ *Andromedæ.* Σ 205.

I was induced to pay considerable attention to this star, because Captain Smyth's measures seemed to indicate a pretty regular increase in distance. My result, however, is smaller than any of the Captain's. During the measures my instrument showed a slight elongation of the companion in the direction 116° ∓, and in November 1851 I saw it *completely divided* in Mr. Pattinson's magnificent refractor of 7¼ inches aperture.

μ *Canis Majoris.* Σ 997.

I have no doubt a change has taken place both in angle and distance, since Struve discovered this very beautiful but somewhat difficult object.

			°		″
Struve	1831·20	Position	343·53	Distance	3·223
Smyth	1834·15	—	342·9	—	3·5
Mädler............	1844·17	—	340·80	—	3·133
Fletcher	1852·60	—	338·07	—	2·947

The angle seems retrograding and the distance diminishing

Castor. Σ 1110.

My observations compared with other recent ones of this object, show that the distance is still slightly augmenting, and the angular motion diminishing, thus showing the general accuracy of the orbits which have recently been calculated by Mr. Hind and M. Mädler. The angles deduced from my observations are not, however, very closely represented by M. Mädler's ephemeris, as will be seen from the following comparison,—

	Observed.		Calculated.	
	°	″	°	″
1851·04	Pos. 248·67	Dist. 5·074	Pos. −2·45	Dist. −0·098
1852·04	247·97	5·074	−2·36	−0·077

That this difference is not attributable to much extent to error in any observed angles, is shown by the correspondence of my first result with that of Mr. Dawes for the same year, which is,—

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* The "B" attached to some of the results by Mr. Dawes, signifies that they were obtained in Mr. Bishop's observatory.

1851·21	Position 248°·12	Distance 5″·068

γ Virginis. Σ 1670.

In 1851 I calculated an orbit for this star, which is published in vol. xi. of the *Notices* of the Society. Since then I have obtained additional measures for two years, and using all other results that have come to my knowledge combined with my own, I have proceeded on Sir John Herschel's graphic process, and arrived at the following orbit, which scarcely differs from my previous one:—

Perihelion Passage	1836·40
Inclination	27° 36′
Position of Ascending Node	19 7
Angle between Lines of Nodes and Apsides	295 13
Excentricity	0·8794
Period in Years	184·53

It is extremely desirable that all observers of double stars should devote the most careful and unremitting attention to this star; and if this be the case, I believe, as Capt. Smyth remarked in a letter to me, "The epoch of 1857 will find the excentricity, inclination, perihelion passage, and period, all in unison." It is very satisfactory to find how closely my result for 1852 corresponds with those of Mr. Dawes and Mr. Miller, all being taken independently and without concert. I subjoin the three results:—

Miller	1852·26	Position 175°·28	Distance 3″·122
Dawes	1852·32	— 175·27	— 3·016
Fletcher	1852·42	— 175·40	— 3·147

ζ Herculis. Σ 2084.

Of late years this extraordinary star has become comparatively of easy measurement in *position*, and I have considerable confidence in my results. As its period is probably shorter than that of any other known binary star, it is very desirable that it should be well watched *now* when it is within the reach of ordinary telescopes. I have computed the elements of its orbit, by Sir John Herschel's method, and have obtained the following results:—

Perihelion Passage	1830·56
Inclination	140° 39′
Position of Node	217 14
Angle between Lines of Nodes and Apsides	266 53
Excentricity	0·4381
Period in Years	37·21

1853MNRAS..13..259M

The period in this case, as well as in that of γ *Virginis*, was obtained by cutting the ellipse out of card-board, and weighing the different portions of it in a delicate balance. Mr. Bishop, in his invaluable volume of observations, has pointed out how enormously in some instances, the angles obtained by different observers about the same epoch differ from each other. It is, therefore, satisfactory to find recent observations agreeing more closely, as will be seen from the following comparison of observations for 1852:—

			°		″
Fletcher	1852·64	Position	83·97	Distance	1·242
Dawes	1852·73	—	82·52	—	1·567
Miller	1852·77	—	84·07		

Mr. Fletcher's paper concludes with a summary of the results of a series of double-star operations carried on in the years 1851 to 1853 at Whitehaven, by J. F. Miller, Esq., F.R.S. These results all relate to objects included in Mr. Fletcher's catalogue, and they have been obtained by an instrument of the same size as Mr. Fletcher's, though differently mounted. It is also the workmanship of Mr. Cooke.

Micrometrical Measures of ξ Ursæ Majoris, made at the Observatory, Whitehaven. By J. F. Miller, Esq. F.R.S.

Magnitudes, 4½, 5. Both stars white.

No.	Position.	Weight.	Obs.	Distance.	Weight.	Obs.*	Epoch.
	° ′			″			
119	119 36	3	8	2·962	2	8	1853·082
121	118 46	2	8	2·991	4	8	·189
122	118 7	4	8	2·974	4	8	·191
131	118 52	4	8	3·097	4	8	·191
Means	118 47	13	32	3·012	14	32	1853·190
Means	122 17	20	57	2·898	18	52	1852·129

Notes on the Experiences of W. S. Jacob, Esq., H.E.I. Co.'s Astronomer, with the new Madras Equatoreal. By Professor Piazzi Smyth.

Having been favoured in my private correspondence with Mr. Jacob during the last year with many particulars of his observations beyond those contained in his recently communicated paper to the Royal Astronomical Society, and as some of these particulars have a high importance when taken in connexion with the observations of other astronomers, recently published in the *Monthly Notices*, and others again are highly worthy of the at-

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* "The distances represent double measures, consequently each set really consists of sixteen observations."